2017-1090

United States Court of Appeals for the Federal Circuit

IN RE JOHN RISSIO and JOHN CAMERON,

Appellants,

APPEAL FROM PATENT AND TRADEMARK OFFICE PATENT TRIAL AND APPEAL BOARD IN NO. 12/672,385

BRIEF OF APPELLANTS JOHN RISSIO AND JOHN CAMERON

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Claim 1 of the Patent Application No. 12/672,385 contains the limitations at issue in this appeal. Claim 1, with the limitations at issue emphasized, reads:

> 1. A method of forming a bio-organic composition, the method comprising:
>
> a) *mixing a fatty acid glyceride-containing composition and a first reaction promoter at a first predetermined temperature to form a first intermediate reaction mixture;*
>
> b) *adding a first epoxide or glycol to the first reaction mixture to form a second intermediate reaction mixture;*
>
> c) *combining at least a portion of the second intermediate reaction mixture with a solvent and additional reaction promoter to form a third intermediate reaction mixture;*
>
> d) *adding a second epoxide to the third intermediate reaction mixture to form a fourth intermediate reaction mixture;* and
>
> e) *removing the solvent such that the bio-organic composition is recovered.*

CERTIFICATE OF INTEREST

Counsel for Appellants, John Rissio and John Cameron, certifies the following:

1. The full name of every party or amicus represented by me is: ________ John Rissio and John Cameron

2. The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by me is: ________ 21st Century R & D, LLC

3. All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party or amicus curiae represented by me are: __ None

4. The names of all law firms and the partners or associates that appeared for the party or amicus now represented by me in the trial court or agency or are expected to appear in this court (and who have not or will not enter an appearance in this case - **do not include names of firms/attorneys who are already on the docket**) are:

None	

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STATEMENT OF RELATED CASES

In accordance with Federal Circuit Rule 47.5, appellants John Rissio and John Cameron (hereinafter “Appellants” or “Applicants”) state that:

(a) No other appeal in or from this same proceeding before the U.S. Patent and Trademark Office, Trademark Trial and Appeal Board, was previously before this or any other appellate court.

(b) Counsel is unaware of any other cases pending in this or any other court that will directly affect or be directly affected by this Court's decision in the pending appeal.

STATEMENT OF JURISDICTION

This appeal is from a Final Written Decision (the "Final Decision") of the Patent Trial and Appeal Board of the United States Patent and Trademark Office issued September 22, 2016 in Patent Application Serial No. 12/672,385 affirming rejection of claims 1-28 under 35 U.S.C. § 103(a). Appx1-17. A Notice of Appeal to this Court was timely filed and served on the Solicitor for the United States Patent and Trademark Office on October 21, 2016 pursuant to 35 U.S.C. § 142, 37 C.F.R. § 90.3, and 28 U.S.C. § 2107(b). Appx217-219. This Court has jurisdiction over the present appeal under 28 U.S.C. § 1295(a)(4)(A) and 35 U.S.C. § 141(a).

STATEMENT OF THE ISSUES

Whether the Patent Trial and Appeal Board erred in affirming the Examiner's final rejection that claims 1-28 were not patentable under 35 U.S.C. § 103(a) over U.S. Pat. No. 4,364,743 (hereinafter referred to as "Erner") in view of U.S. Patent 6,310,233 B1 (hereinafter referred to as "Maurer")?

STATEMENT OF THE CASE

At issue in this case is the Appellants' application for a patent on a method for modifying fats and oils for fuel and lubricating applications and a composition derived from the method. The Patent Trial and Appeal Board (hereinafter referred to as"the Board") affirmed the Examiner's rejection of Claims 1-28 in the patent application covering that method and related composition. This appeal follows.

A. Appellants' Patent Application

The present application was filed on August 8, 2008 as Patent Application Serial No. 12/672,385 (hereinafter referred to as "the Application"). Appx24-43. The Application is directed to a method of forming a bio-organic composition and an internal combustion engine utilizing said bio-organic composition. Appx26. The method includes a step of mixing a fatty acid glyceride-containing composition, and a first reaction promoter at a first predetermined temperature to form a first intermediate reaction mixture. Appx31. A first epoxide or glycol is added to the first reaction mixture to form a second intermediate reaction mixture. *Id*. At least a portion of the second intermediate reaction mixture is combined with a solvent and additional reaction promoter to form a third intermediate reaction mixture. Appx32. A second epoxide is added to the third intermediate reaction mixture to form a fourth intermediate reaction mixture. *Id*. The solvent is removed such that the bio-organic composition is recovered. Appx36.

In another embodiment as set forth in independent claim 16, a bio-organic composition is provided. Appx26. The bio-organic composition includes residues of a fatty acid glyceride-containing composition. *Id.* The fatty acid glyceride-containing composition has a first viscosity and a first pour point. *Id.* The composition also includes residues of a first epoxide present in a first epoxide concentration or residues of a first glycol present in a first glycol concentration and residues of a second epoxide present in a second epoxide concentration. *Id.* The first epoxide is the same or different than the second epoxide. *Id.* The first and second concentrations are such that the bio-organic composition has a viscosity lower that the first viscosity and/or a pour point lower than the first pour point. *Id.*

In another embodiment as set forth in independent claim 28, an internal combustion engine system is provided. Appx36. The system includes a fuel supply system for providing a bio-diesel fuel composition and an internal combustion engine in fluid communication with the fuel supply system. *Id.* The internal combustion engine is adapted to combust bio-diesel fuel received from the fuel supply system. *Id.* The bio-organic composition includes residues of a fatty acid glyceride-containing composition. Appx26. The fatty acid glyceride-containing composition has a first viscosity and a first pour point. *Id.* The composition also includes residues of a first epoxide present in a first epoxide concentration or residues of a first glycol present in a first glycol concentration and residues of a second epoxide present in a second epoxide concentration. *Id*. The first epoxide is the same or different than the second epoxide. *Id*. The first and second concentrations are such that the bio-organic composition has a viscosity lower that the first viscosity and/or a pour point lower than the first pour point. *Id*.

B. Examiner's Rejection

Following the filing of the Application, the Examiner issued a series of rejections. The Examiner rejected all of Appellants' claims, 1-28, under 35 U.S.C. § 103(a) as being unpatentable over Erner in view of Maurer. Appx117. Erner discloses the reaction of free carboxylic acids or fatty acids with epoxides. Appx223. Maurer is directed to the preparation of monomers from dicarboxylic acids to be used in forming polyesters. Appx226. The Examiner alleged that Erner discloses the reaction of free carboxylic acid with epoxide to form synthetic fuel and that Mauer taught the addition of solvent and addition of reaction promoters to the reaction rendering the claims obvious. Appx151.

Applicants traversed the rejection noting that the sequence of steps of the reaction was not taught or suggested by Erner in view of Maurer. Appx134. Applicants also noted the superior performance of the invention and provided evidence of the same. Appx135-136; Appx138-145.

However, in the Examiner's view, the combination of Erner and Maurer rendered the claims obvious despite the complexity of the chemical reaction in the present application and the claims were rejected again in the Final Office Action. Appx151. The Examiner alleged that the sequence of steps was taught because Erner teaches the continuous addition of epoxide, which may be equated to two distinct steps. Appx154.

After receipt of the Final Office Action, the Applicants' appealed to the Board. Applicants again noted the multistep reaction required by the claims was not taught or suggested in Erner or Mauer. Appx171. Applicants also noted that Erner discloses the use of free fatty acids and Maurer discloses the use of dicarboxylic acids, whereas the present method uses a fatty acid-glyceride containing composition. Appx172. Applicants also argued that claim 16 is independently allowable given the lack of teaching where the epoxides are different. Appx175.

While the Applicants' brief was pending before the Board, the Examiner withdrew the appealed rejections and applied new obviousness rejections, again on Erner and Maurer. Appx196-203.

C. Patent Trial and Appeal Board's Cursory Affirmance of the Examiner's Final Rejection of the Claims

The Board affirmed the Examiner's obviousness rejection under 35 U.S.C. § 103(a) that "the combined disclosures of Erner and Maurer would have suggested the process recited in claim 1 to one of ordinary skill in the art at the time of the invention." Appx7. The Board erred in upholding the Examiner's rejection for the reasons set forth herein.

SUMMARY OF THE ARGUMENT

In determining claims 1-28 were obvious in view of the prior art, the Board erred for three reasons.

A. Erner and Maurer do not disclose all the limitations of claim 1.

Erner discloses epoxide addition to free fatty acid. Maurer discloses epoxide addition to dicarboxylic acid. The Examiner relied upon the use of free fatty acids as the reactant in Erner and dicarboxylic acids as the reactant in Maurer as sufficient disclosure for the claim limitation in the present invention requiring the reactant to be glyceride-containing composition. This is not a complete disclosure. Fatty acid glyceride-containing composition contains additional chemical moieties not present in free fatty acid or dicarboxylic acid. These chemical moieties are available for the reaction. The cited prior art does not disclose the combination of a fatty acid glyceride-containing composition with epoxide.

B. The cited art also does not disclose the multistep method required by the present invention.

The Board seemingly accepted the Examiner's statement that "there is no reason to believe that rearranging the order of steps of adding reactants and catalyst and solvent would result in a change in the end product." Appx204. This defies chemical logic given the highly reactive nature of epoxide and glycol. The claimed method requires the addition of epoxide after the addition of solvent, which will result in the formation of products that are contained within the final product. Neither

Erner nor Maurer contemplate such a reaction given their single step processes. The sequence of steps is inherent to the chemical reactions occurring in the method. There is no motivation or reason to combine Maurer and Erner to achieve the claimed invention.

Erner's teachings are directed to preparation of a biofuel using free fatty acid. Maurer's teachings are directed to preparation of starting materials for the formation of polyesters using dicarboxylic acid. The Examiner cites to no reference that would motivate a person of ordinary skill in the art to combine the cited references. Erner and Maurer are used in two different technologies and utilize two chemically distinct reactants. The Board improperly affirmed the Examiner's use of disparate technologies to sustain the rejection.

C. The secondary considerations presented overcome any evidence of obviousness.

Appellants' evidence of superior performance is indicative of nonobviousness. The Board erred in disregarding evidence of secondary considerations presented to the Examiner. Appellants submitted compelling evidence of increased mileage achieved by using the present invention compared to the closest prior art. When properly considered, the evidence provided is sufficient to overcome any proper rejection based on obviousness.

Under proper analysis, claims 1-28 are patentable, and the Board's decision should be reversed for at least these reasons.

STANDARD OF REVIEW

The Court reviews the Board's legal determinations de novo and its underlying factual determinations for substantial evidence. *In re Efthymiopoulos*, 839 F.3d 1375, 1377 (Fed. Cir. 2016). Obviousness "is a question of law, based on factual determinations regarding the scope and content of the prior art, differences between the prior art and the claims at issue, the level of ordinary skill in the pertinent art, and any objective indicia of non-obviousness." *Randall Mfg. v. Rea*, 733 F.3d 1355, 1362 (Fed. Cir. 2013). Under the substantial evidence standard, the Court affirms the Board's factual determinations if they are based upon "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." *Unwired Planet, LLC v. Google Inc.*, 841 F.3d 995, 1000 (Fed. Cir. 2016).

ARGUMENT

A. The Board erred in concluding claims 1-28 are obvious because the combination of Erner and Maurer do not teach or suggest all the required limitations in claim 1.

The method for obtaining bio-organic compositions as set out in the claims is not obvious. The factual determinations on which the Board based its conclusion of obviousness are not supported by substantial evidence. The prior art does not disclose all the required chemical reactions and compounds and no other disclosed method in the prior art teaches or suggests the claimed multi-step reaction required to produce the claimed chemical product.

1. The combination of Erner and Maurer does not disclose the entirety of the chemical reactions and compounds present in claim 1.

The prior art need not teach each claim limitation, but it must "contain[] some reason why one of skill in the art would modify the prior art to obtain the claimed invention." *Nike, Inc. v. Adidas AG*, 812 F.3d 1326, 1335 (Fed. Cir. 2016). The "mere chemical possibility that one of [the] prior art [starting materials] could be modified such that its use would lead to the particular [starting material] does not make the process recited . . . obvious 'unless the prior art suggested the desirability of [such a] modification.'" *In re Ochiai*, 71 F.3d 1565, 1570 (Fed. Cir. 1995) (quoting *In re Gordon*, 733 F.2d 900, 902 (Fed.Cir.1984)). Where a prior art reference teaches "a generic chemical reaction . . . the mere fact that a device or process utilizes a known scientific principle does not alone make that device or process obvious." *In re Brouwer*, 77 F.3d 422, 425 (Fed. Cir. 1996).

The Board accepted the Examiner's argument and concluded that "one of ordinary skill in the art reasonably would have used [water-catalyzed hydrolysis of oil] to prepare the free fatty acids derived from vegetable oils disclosed in Erner." Appx8. The Board seemingly relied on this statement to show that Erner rendered the use of oil, or a fatty acid glyceride-containing composition, in an epoxide addition reaction obvious. However, Erner simply suggests that the reactant used by its claimed method (free fatty acid) may be derived from a glyceride-containing composition (oil) through transesterification. Appx223. Neither Erner nor any other reference provided teaches or even suggests why one of skill in the art would use the fatty acid glyceride-containing composition as the reactant in an epoxide addition reaction. The glyceride-containing composition contains additional chemical moieties available for the reaction.

When determining whether a claim is obvious, an examiner must make "a searching comparison of the claimed invention – *including all its limitations* – with the teaching of the prior art." *Ochiai*, 71 F.3d at 1572 (emphasis added). Thus, "obviousness requires a suggestion of all limitations in a claim." *CFMT, Inc. v. Yieldup Intern. Corp.*, 349 F.3d 1333, 1342 (Fed. Cir. 2003) (*citing In re Royka*, 490 F.2d 981, 985 (CCPA 1974)).

Therefore, not every limitation of the claimed method is disclosed and the obviousness rejection cannot be sustained.

The claimed method is in no way directed towards using free fatty acids derived from oil in an epoxide addition reaction. The first step of the method involves combining a "fatty acid glyceride-containing composition and a first reaction promoter" followed by a second step of adding "a first epoxide or glycol." Appx20. The chemical reactions occurring in these two steps would not result in only the formation of free fatty acids. Instead, the first step would form the conjugate base of a fatty acid since the reaction promoters are bases plus the remaining organic components of the fatty acid glyceride-containing composition after the conjugate base has been cleaved. Appx29. A fatty acid glyceride-containing composition is not in any way equivalent to a free fatty acid because a fatty acid glyceride-containing composition contains these additional chemical moieties not present in a simple free fatty acid. Moreover, these additional chemical moieties and reaction products thereof that will also be present in the final composition.

The Board recognized that Erner discloses "a synthetic fuel comprising fatty acid esters that are prepared by epoxide addition of free fatty acids derived from vegetable oils." Appx5. The Board erred in concluding that addition of epoxide to a fatty acid glyceride-containing composition was rendered obvious by a free fatty acid epoxide addition reaction simply because free fatty acids may be obtained through hydrolysis of a fatty acid glyceride-containing composition. Such disclosure is wholly insufficient to render addition of epoxide to a fatty acid glyceride-containing composition obvious. This conclusion disregards that the claimed method does not involve free fatty acids in any respect and it is mere conjecture that such free fatty acids are generated in the claimed methods. The claimed method is a series of reactions between a fatty acid glyceride-containing composition, or oil, and epoxide that results in different chemical reactions leading to the formation of different products than that of Erner or Mauer. The fact that Erner uses the product of a hydrolysis of an oil in its method is irrelevant to the claimed method.

Erner only discloses epoxide addition to free fatty acids without contemplating or providing a reason to conduct epoxide addition with the fatty acid glyceride-containing composition. Erner makes no reference to combining oil with epoxide. Erner only describes how you can obtain free fatty acids from vegetable oil and leaves out any motivation or mention of what would result from epoxide addition to the vegetable oil prior to hydrolysis. Moreover, Maurer in no way cures the deficiencies of Erner in this regard as it makes no mention of using free fatty acids or vegetable oils at all, but instead describes epoxide addition to dicarboxylic acids. Appx229. Neither reference discloses or provides any motivation for combining fatty acid glyceride-containing composition with epoxide, therefore, the references do not teach or suggest each claim limitation in the claimed method. *Par*

Pharmaceutical, Inc. v. TWi Pharmaceuticals, Inc., 773 F.3d 1186, 1194 (Fed. Cir. 2014): All claimed elements must be disclosed in the prior art before considering motivation to combine and reasonable expectation of success, citing *Medichem, S.A. v. Rolabo, S.L.,* 437 F.3d 1157, 1164 (Fed.Cir.2006) (stating that we consider motivation to combine and reasonable expectation of success only "if all the elements of an invention are found in a combination of prior art references").

Accordingly, the obviousness rejection is not proper and should be reversed.

2. Erner and Maurer fail to disclose the multistep process required by Claim 1.

The Board erred by disregarding the importance of the sequence of steps in a chemical reaction. The sequence of steps in a chemical reaction is fundamental to the nature of the patented process. Where the sequence of steps or the results obtained thereby is unsuggested by the prior art, a multi-step process is patentable even if the individual steps are taught. *Ex parte Baril et al,* 124 USPQ 509 (POBA 1958); *Ex parte Kane,* 125 USPQ 70 (POBA 1960); *Ex parte Bond,* 135 USPQ 160 (POBA 1961); *Trio Process Corp. v. L. Goldsteins' Son's, Inc.,* 461 F.2d 66 (3d Cir. 1972). "It may be true that the individual steps per se are present in the references relied upon, but the procedure in the sequence as claimed is not suggested therein and the rejection cannot be sustained." *Baril,* 124 USPQ 509.

The sequence of steps of the claimed method are in no way suggested by the simple reaction of free fatty acid with an epoxide as disclosed in Erner. The claimed method involves the formation of at least four intermediate mixtures before the bio-organic composition is obtained. The intermediate steps are inherent to the overall product given the chemical nature of the invention. The claimed method requires addition of a first reaction promoter to a fatty acid glyceride-containing composition (step a), followed by addition of a first epoxide or glycerol (step b), followed by addition of a solvent (step c), followed by addition of a second epoxide (step d), followed by removal of the solvents (step e). Each of these successive steps results in a different chemical composition in the mixture resulting in different chemical reactions that do not simply equate to epoxide addition with a free fatty acid as described in Erner.

Per the Board, Erner discloses "continuous or further addition of an epoxide to the reaction until it is complete corresponds to adding a second epoxide as recited in step d) of claim 1." Appx8. The Board also stated Appellants do not dispute this finding. Appx5. However, the Appellants' brief highlights that Erner and Maurer fail to disclose "adding an epoxide to a reaction mixture containing a fatty acid glyceride-containing composition before adding a solvent . . . and adding an epoxide after the solvent addition." Appx171. This "continuous or further addition" cannot be equated to step d) of the claimed method because it fails to consider the products and chemical composition of the mixture formed when the solvent as well as the additional reaction promoter first added in step c) prior to the addition of a second epoxide in step d).

When the reaction mixture includes a first epoxide, the solvent added in step c) will inevitably react with the first epoxide given that epoxides are extremely reactive due to their strained three membered ring structure. Appx173. When epoxide reacts with the solvent additional products are formed that are included in the final product because step e) only requires the removal of solvent. Appx173. The combination of Mauer and Erner does not contemplate the reaction of epoxide with solvent that occurs in the claimed method. Moreover, the combination of the two references does not result in a product that includes the products of the inevitable reaction between solvent and epoxide.

Each step of the chemical process produces a unique composition of chemical compounds that affect the reactions that occur upon the addition of each chemical material. Erner and Maurer make no suggestion to the effects of adding a solvent and additional reaction promoter followed by addition of a second epoxide. Erner's suggestion that epoxide is continuously added until the reaction reaches completion does not suggest addition of a second epoxide after adding additional reaction promoter and solvent; therefore, step d) requiring the addition of a second epoxide is not suggested within the claims and therefore the rejection cannot be sustained.

B. The Board erred because there is no reason to combine Maurer and Erner to achieve the claimed invention.

In rejecting claims under 35 U.S.C. § 103, the Examiner bears the initial burden of presenting a *prima facie* case of obviousness. *See In re Rijckaert*, 9 F.3d 1531, 1532 (Fed. Cir. 1993). A *prima facie* case of obviousness is established by presenting evidence that would have led one of ordinary skill in the art to combine the relevant teachings of the references to arrive at the claimed invention. *See Procter & Gamble Co. v. Teva Pharm. USA, Inc.*, 566 F.3d 989, 994 (Fed. Cir. 2009); *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988) and *In re Lintner*, 458 F.2d 1013, 1016 (CCPA 1972).

The motivation to combine "need not be found in the references sought to be combined, but may be found in any number of sources, including common knowledge, the prior art as a whole, or the nature of the problem itself." *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1361 (Fed. Cir. 2006).

However, the key to supporting any rejection under 35 U.S.C. § 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR* noted that ***the analysis supporting a rejection under 35 U.S.C. 103 should be made explicit***. The Court quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006), stated that "'[R]ejections on obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.'" *KSR*, 550 U.S. at 418. Appellants submit the Examiner's reasons for combining the references do not meet *KSR*'s standard, for reasons stated presently. Maurer teaches a process that uses dicarboxylic acids. Erner teaches a process using free fatty acids that may be obtained through hydrolysis of oils. Fatty acids are not dicarboxylic acids. Fatty acids are monocarboxylated compounds including a long aliphatic tail. Although, as the Board noted, "both dicarboxylic acids and free fatty acids possess the same acidic functional groups" the difference between the two is nonetheless substantial. Appx9. Dicarboxylic acids do not possess the carbon chain in the present invention that, through reaction with the epoxides, produces different product compounds present in the final composition and are therefore not suitable to be substituted. One skilled in the art would recognize the differences between the two reactants and conclude that although they do share some functional groups, they are otherwise distinct in their chemistry and reactivity.

Moreover, Maurer is directed to preparing monomers used in the polymerization to polyesters, and therefore, on its face completely irrelevant to the present rejection. The Board rejected this evidence stating "hydroxyalkyl esters produced by Erner's epoxide addition reactions are inclusive of the hydroxylalkyl ester monomers produced by Maurer's ethoxylation reaction." Appx11. However, the Board disregarded the prior art as a whole. The Board failed to consider that Maurer is directed towards preparation of polyesters and is completely irrelevant to production of biofuels. Thus, the references cannot be properly combined to render the claimed method obvious and the rejection cannot be sustained.

C. The Board erred by failing to consider the evidence of superior performance of the resulting composition.

An applicant may show with evidence that the claimed invention exhibits some superior property or advantage that a person of ordinary skill in the relevant art would find surprising or unexpected. *In re Mayne*, 104 F.3d 1339, 1343 (Fed. Cir. 1997). In chemistry, "there is often great difficulty in predicting precisely how a given compound will behave." *Application of Carleton*, 599 F.2d 1021, 1026 (CCPA 1979). This court has held that "when unexpected results are used as evidence of nonobviousness, the results must be shown to be unexpected compared with the closest prior art." *In Re Baxter Travenol Labs.*, 952 F.2d 388, 392 (Fed.Cir.1991).

The Board incorrectly found that the unexpected results needed to be compared to Erner when the closest available prior art is Bio Diesel 99 and F-85 fuels. Both Bio Diesel 99 and F-85 fuels are compared directly to the present invention. Appx138-145. Compared with the closest prior art, Bio Diesel 99, the current invention, BF 100 Bio-Diesel Fuel, shows an improvement of 3.0 to 4.0 mile per gallon. Appx140. The Bio-Fuel Gasoline shows an improvement of 1.0 to 2.1 miles per gallon above current F-85 fuels. *Id*. These improvements obtained using compositions derived from the claimed method are a direct result of the chemistry involved in their production and represent valuable improvements to current automotive fuel economy. It is unexpected that by analyzing the chemical reactions utilized to obtain the final compositions that such improvements in the fuel efficiency would be obtained, thus each step although generic in chemical nature, have been ordered in a way that allows for a final composition that unexpectedly increases the fuel efficiency by notable amounts. Thus, the unexpected results achieved by use of the composition obtained by the claimed method are probative indicia of nonobviousness.

CONCLUSION AND RELIEF SOUGHT

The Board erred in affirming the Examiner's analysis of what the prior art references disclosed, and whether a person of skill in the art would have been motivated to combine or modify them with a reasonable expectation of success to realize the invention of claims 1-28. The Board's affirmance was not based on relevant evidence a reasonable mind might accept as adequate to support the Examiner's factual findings underlying the obviousness determination. Moreover, neither the Examiner nor the Board articulated adequate reasoning with some rational underpinning to support a motivation to combine the applied references. The

Board also erred as a matter of law by failing to consider the secondary considerations provided as evidence of unexpected results.

Given these factual and legal errors, Appellants respectfully request that this Court reverse the Board's decision and hold that Claims 1-28 of the patent application are patentable. Alternatively, Appellants requests that this Court vacate the Board's decision and remand to the United States Patent and Trademark Office with appropriate instructions.

Respectfully submitted,

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Date: February 3, 2017

ADDENDUM

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UNITED STATES PATENT AND TRADEMARK OFFICE

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte JOHN RISSIO and JOHN CAMERON

Appeal 2015-004135
Application 12/672,385
Technology Center 1700

Before CHUNG K. PAK, JEFFREY T. SMITH, and
WESLEY B. DERRICK, *Administrative Patent Judges*.

PAK, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants[1] appeal under 35 U.S.C. § 134(a) from the Examiner's decision rejecting claims 1 through 28. We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM.

The subject matter on appeal is generally directed to a method of forming a bio-organic composition and to a bio-organic composition. (Spec. 2, ll. 9–18.)

[1] Appellants do not identify the Real Party in Interest. (*See generally* Appeal Brief filed July 21, 2014 ("App. Br.").)

Details of the appealed subject matter are recited in representative claims 1 and 16, which are reproduced below from the Claims Appendix to the Appeal Brief:

1. A method of forming a bio-organic composition, the method comprising:

a) mixing a fatty acid glyceride-containing composition and a first reaction promoter at a first predetermined temperature to form a first intermediate reaction mixture;

b) adding a first epoxide or glycol to the first reaction mixture to form a second intermediate reaction mixture;

c) combining at least a portion of the second intermediate reaction mixture with a solvent and additional reaction promoter to form a third intermediate reaction mixture;

d) adding a second epoxide to the third intermediate reaction mixture to form a fourth intermediate reaction mixture; and

e) removing the solvent such that the bio-organic composition is recovered.

16. A bio-organic composition comprising:

residues of a fatty acid glyceride-containing composition, the fatty acid glyceride-containing composition having a first viscosity and a first pour point;

residues of a first epoxide present in a first epoxide concentration or residues of a first glycol present in a first glycol concentration; and

residues of a second epoxide present in a second epoxide concentration, wherein the first epoxide is the same or different than the second epoxide and wherein the first and second concentrations are such that the bio-organic composition has a viscosity lower that [*sic*] the first viscosity and/or a pour point lower than the first pour point.

The Examiner entered a new ground of rejection in the Answer entered on December 22, 2014 ("Ans.") of claims 1–28 under 35 U.S.C. § 103(a) as unpatentable over the disclosures of U.S. Patent 4,364,743 issued in the name of Erner on December 21, 1982 (hereinafter referred to as "Erner") in view of U.S. Patent 6,310,233 Bl issued in the name of Maurer et al. on October 30, 2001 (hereinafter referred to as "Maurer"). (Ans. 2–6.) The Examiner also relied upon Holliday et al., "Hydrolysis of Vegetable Oils in Sub- and Supercritical Water," Ind. Eng. Chem. Res., Vol. 36, No. 3, pp. 932–35 (1997), and Susanti et al., Supercritical Fluid Technology for Energy and Environmental Applications, pp 113–15 (Vladimir Anikeev and Maohong Fan, eds., 2014), to support the official notice that obtaining free fatty acids from glycerides in vegetable oils by hydrolysis reaction (in the presence of water at high temperature) was well known in the art at the time of the invention. (Ans. 10–11.)

DISCUSSION

Upon consideration of the evidence on this appeal record and each of Appellants' contentions, we determine that Appellants have not identified reversible error in the Examiner's rejection of claims 1–28 under 35 U.S.C. § 103(a). Accordingly, we affirm this rejection for the reasons set forth in the Answer. We add the discussion below primarily for emphasis and completeness.

Claims 1–10, 15, 17–19, and 23–28[2]

Appellants do not dispute the Examiner's finding that Erner discloses a synthetic fuel comprising fatty acid esters that are prepared by epoxide addition of free fatty acids derived from vegetable oils (fatty acid glyceride-containing composition). (*Compare* Ans. 3 *with* App. Br. 3–8.) The Examiner acknowledged that Erner does not explicitly disclose the process of deriving the free fatty acids from vegetable oils, but took the official notice and provided evidence that hydrolysis of vegetable oils to form free fatty acids was a conventional process at the time of the invention, involving conversion of water at high temperature into ions (first reaction promoter) that catalyze the formation of free fatty acids from vegetable oils (fatty acid glyceride-containing composition) (corresponding to step a) of claim 1). (Ans. 3, 10–11.)

Appellants also do not dispute the Examiner's finding that Erner discloses an epoxide addition reaction involving reacting the free fatty acids derived from vegetable oils (first intermediate reaction mixture) with alkylene oxides such as ethylene or propylene oxides (first epoxide) at temperatures between 105ºC and 120°C in the presence of a potassium hydroxide catalyst (corresponding to step b) of claim 1). (*Compare* Ans. 3 *with* App. Br. 3–8.) Nor do Appellants dispute the Examiner's finding that Erner discloses adding the epoxide continuously or further until the reaction is complete, which according to the Examiner, corresponds to adding a second epoxide as recited in step d) of claim 1. (*Compare* Ans. 4 *with* App. Br. 3–8.)

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[2] We limit our discussion to those claims separately argued, and claims not separately argued stand or fall with the argued claims. 37 C.F.R. § 41.37(c)(1)(iv). Appellants argue claims 1–10, 15, 17–19, and 23–28 as a group on the basis of claim 1. (*See generally* App. Br. 3–8.) Therefore, for the purposes of this appeal, we select claim 1 as representative, and decide the propriety of the rejection of claims 1–10, 15, 17–19, and 23–28 based on claim 1 alone.

The Examiner acknowledged that Erner does not disclose adding solvent and an additional reaction promoter to the reaction (corresponding to step c) of claim 1), and relied on Maurer for this feature missing from Erner's disclosures. (Ans. 3–4.) Appellants do not dispute the Examiner's finding that Maurer discloses a process for preparing hydroxyl alkyl esters that involves reacting one or more dicarboxylic acids with one or more alkylene oxides in the presence of a solvent, an optional co-solvent such as water or methanol, and an optional catalyst (corresponding to step c) of claim 1). (*Compare* Ans. 4 *with* App. Br. 3–8.) Nor do Appellants dispute the Examiner's finding that Maurer discloses removing the solvents from the reaction products subsequent to the epoxide addition reaction (corresponding to step e) of claim 1). (*Compare* Ans. 4 *with* App. Br. 3–8.) Because both Erner and Maurer disclose an epoxide addition reaction for producing hydroxyl alkyl esters, the Examiner concluded that it would have been obvious to one of ordinary skill in the art at the time of the invention to add an optional solvent such as water and catalyst (reaction promoter) to the epoxide addition reaction disclosed in Erner. (Ans. 4.)

Appellants argue that Erner fails to disclose a multistep process in which epoxides are added to a reaction mixture before and after addition of a solvent, as recited in claim 1. (App. Br. 4–5.) Appellants further argue that Maurer fails to cure the deficiencies of Erner because Maurer, like Erner, does not disclose or suggest a multistep process as recited in claim 1 in which at least four intermediate mixtures are formed, and Maurer's reactions conditions are incompatible with those of Erner. (App. Br. 6–8.) Appellants also argue that Maurer is directed to the preparation of monomers from dicarboxylic acids, which differ from fatty acid glycerides and free fatty acids. (App. Br. 6.)

However, we agree with the Examiner that the combined disclosures of Erner and Maurer would have suggested the process recited in claim 1 to one of ordinary skill in the art at the time of the invention, for at least the following reasons.

Erner discloses a method for preparing fatty acid esters that involves epoxide addition of free fatty acids derived from vegetable oils such as coconut oil, corn oil, cottonseed oil, palm oil, and safflower oil, which, according to Appellants, contains fatty acid glyceride. (Erner col. 5, ll. 51–

62; col. 6, ll. 28–40 and Spec. 4, ll. 15–20.) The Examiner provided evidence demonstrating that hydrolysis of vegetable oils (fatty acid glyceride-containing compositions) to form free fatty acids—corresponding to step a) of claim 1—was a conventional process at the time of the invention in which ions formed from water (first reaction promoter) catalyze the reaction. (Ans. 10–11 *citing* Holliday, et al., *Hydrolysis of Vegetable Oils in Sub- and Supercritical Water*, 36 Ind. Eng. Chem. Res. 932 (1997), and Susanti et al., Supercritical Fluid Technology for Energy and Environmental Applications, pp 113–15 (Vladimir Anikeev and Maohong Fan, eds., 2014).) Accordingly, we concur with the Examiner that one of ordinary skill in the art reasonably would have used such a conventional process to prepare the free fatty acids derived from vegetable oils disclosed in Erner.

As also indicated *supra*, there is no dispute that that Erner's disclosure of an epoxide addition reaction in which free fatty acids derived from vegetable oils are reacted with ethylene oxide or propylene oxide (first epoxide) using potassium hydroxide as a catalyst (reaction promoter) corresponds to step b) of claim 1, and Erner's disclosure of continuous or further addition of an epoxide to the reaction until it is complete corresponds to adding a second epoxide as recited in step d) of claim 1. (Ans. 3; Erner col. 6, ll. 28–40.) Although Erner does not mention adding a solvent and an additional promoter during its epoxide addition reaction as required by step

c) of claim 1 or removing the solvent after its epoxide addition reaction as required by step e) of claim 1, the Examiner correctly found that Maurer discloses a process for preparing hydroxyl alkyl esters in its epoxide addition reaction in the presence of an optional co-solvent such as water or methanol, and an optional catalyst as recited in step c) of claim 1 and removing the solvent after forming the hydroxyl alkyl esters as recited in step e) of claim 1. In particular, Maurer, like Erner, discloses a process for producing hydroxylalkyl esters. (Maurer col. 4, ll. 33–37; Erner col. 6, ll. 37–38.) Maurer also discloses a process that involves ethoxylation of dicarboxylic acids using alkylene oxide, which is an epoxide addition reaction like the one described in Erner. (Maurer col. 3, ll. 35–38; Erner col. 6, ll. 35–36.) As Appellants point out, Maurer's reaction utilizes dicarboxylic acids as the starting material, rather than free fatty acids as utilized by Erner, but both dicarboxylic acids and free fatty acids possess the same acidic functional groups. (App. Br. 6; Maurer col. 4, ll. 33–37; Erner col. 6, ll. 28–31.) Maurer discloses that the ethoxylation reaction (epoxide addition reaction) is conducted at a temperature of 100ºC to 240ºC, overlapping the temperature used for Erner's epoxide addition reaction (105ºC to 120ºC). (Maurer col. 5, ll. 29–31; Erner col. 6, ll. 31–33.) Maurer further discloses conducting the ethoxylation reaction in the presence of an optional catalyst and an optional co-solvent, which can be water or methanol, and discloses removing the co-solvent and catalyst after completion of the reaction. (Maurer col. 4, ll. 33–

38; col. 5, ll. 13–15; col. 6, ll. 11–22.) Therefore, contrary to Appellants' arguments, Maurer's reaction conditions are not incompatible with the conditions used for Erner's reaction.

Because Mauerer discloses that an optional co-solvent such as water or methanol can be used in an epoxide addition reaction to produce the same product from starting materials having the same reactive functional group at the same temperature as Erner's epoxide addition reaction, one of ordinary skill in the art reasonably would have understood that Mauer's optional co-solvent could also be present during Erner's reaction contrary to Appellants' argument. Furthermore, because Erner's epoxide addition reaction involves continuous addition of epoxide, one of ordinary skill in the art reasonably also would have understood that the optional co-solvent could—like the epoxy—be added during the course of the ongoing reaction. Thus, we concur with the Examiner that the combined disclosures of Erner and Maurer reasonably would have led one of ordinary skill at the time of the invention to add the optional co-solvent disclosed in Maurer to the epoxide addition reaction disclosed in Erner at any point during the reaction, including at the beginning of the reaction, or during the course of the reaction after an initial addition of epoxide, but before a further addition of epoxide as recited in step c) of claim 1.

Appellants' arguments do not demonstrate that Maurer's optional co-solvent would not be useful in Erner's epoxide addition reaction involving the same reaction chemistry as Mauer's ethoxylation reaction. Nor do Appellants' arguments establish the criticality of the timing of the solvent addition in the method of claim 1. *Cf. In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990) (indicating that in cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range.). Appellants' arguments are therefore unpersuasive of reversible error.

Appellants also argue that "Maurer is directed to preparing monomers used in the polymerization to polyesters, and therefore, on its face completely irrelevant to the present rejection." (App. Br. 6.) However, the hydroxyalkyl esters produced by Erner's epoxide addition reaction are inclusive of the hydroxylalkyl ester monomers produced by Maurer's ethoxylation reaction. Both Mauer and Erner are directed to producing the same products using the same reaction chemistry and thus one of ordinary skill in the art interested in improving the process of Erner would look to Mauer, and their combined disclosures would have suggested the process recited in claim 1 as discussed above, regardless of whether the products of Maurer's reaction are intended to be used in a further reaction. Appellants' arguments are therefore unpersuasive of reversible error.

Appellants further argue that the Examiner impermissibly speculates in asserting that water reacts with a fatty acid glyceride-containing composition, such as vegetable oil, to form free carboxylic acids, or free fatty acids. (App. Br. 6.) However, as discussed above, the Examiner took an official notice and provided evidence in the Answer establishing that hydrolysis of vegetable oils to form free fatty acids was a conventional process at the time of the invention involving the conversion of water at high temperature into ions that catalyze the conversion of vegetable oils into free fatty acids. Appellants' arguments are therefore unpersuasive of reversible error.

Appellants also argue that the evidence provided in Exhibits A–C of the Appeal Brief establishes that the bio-organic composition produced by the process of claim 1 exhibits superior performance over commercial bio-diesel products, demonstrating "the unique nature of this sequence of steps" recited in claim 1. (App. Br. 3–4.) However, Exhibits A–C do not describe the method that was used to produce the bio-organic composition that was tested and do not compare such bio-organic composition to the bio-organic composition taught by Erner, the closest prior art. Accordingly, it is impossible to determine whether the asserted superior bio-organic composition was produced according to the method of claim 1 and has unexpected properties relative to those produced by the closest prior art, namely Erner. Thus, we determine that the evidence provided in Exhibits

A–C does not outweigh the evidence of obviousness proffered by the Examiner.

Therefore, we sustain the Examiner's rejection of claims 1–10, 15, 17–19, and 23–28 under 35 U.S.C. § 103(a).

Claims 11 and 16

Appellants assert that claims 11 and 16 require the first epoxide to be ethylene oxide and the second epoxide to be propylene oxide, and argue that the Examiner does not identify any teaching in the applied prior art in which two different epoxides are utilized. (App. Br. 8.)

However, claim 16 recites that "the first epoxide is the same or different than the second epoxide," and Appellants' arguments regarding this claim therefore lack merit.

With respect to claim 11, Erner discloses that the epoxide addition reaction involves introduction of ethylene oxide or propylene oxide to a mixture of free fatty acids. (Erner col. 6, ll. 31–33.) Erner thus indicates that ethylene oxide and propylene oxide can be used interchangeably to effect epoxide addition of free fatty acids. Accordingly, one of ordinary skill in the art reasonably would have been led to use either ethylene oxide or propylene oxide, or a combination of both ethylene oxide and propylene oxide as recited in claim 11, in Erner's epoxide addition reaction, with a reasonable expectation that using a combination of both epoxides would result in a successful epoxide addition reaction to produce hydroxylalkyl esters. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (*quoting Sakraida v. Ag Pro, Inc.*, 425 U.S. 273, 282 (1976) ("[W]hen a patent 'simply arranges old elements with each performing the same function it had been known to perform' and yields no more than one would expect from such an arrangement, the combination is obvious."); *In re Kerkhoven*, 626 F.2d 846, 850 (CCPA 1980) ("It is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition which is to be used for the very same purpose.") Appellants' arguments are therefore unpersuasive of reversible error.

Therefore, we sustain the Examiner's rejection of claims 11 and 16 under 35 U.S.C. § 103(a).

Claims 12–15 and 20–23[3]

Claim 12 recites a bio-organic composition prepared according to the method of claim 1 that has a viscosity of less than or equal to about 30 centipoise at 25°C, while claim 14 also recites a bio-organic composition prepared according to the method of claim 1, which has a pour point less than or equal to about 0°F. The Examiner finds that the process for producing hydroxyalkyl esters disclosed in Erner as modified by Maurer is substantially similar to the process recited in claim 1, and the Examiner determines that one of ordinary skill in the art would have expected that the products formed from both processes would have similar viscosities and pour points, such as those recited in claims 12 and 14. (Ans. 5.)

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[3] Appellants argue claims 12–15 and 20–23 as a group. (App. Br. 8–9.) Therefore, for the purposes of this appeal, we select claims 12 and 14 as representative, and decide the propriety of the rejection of claims 12–15 and 20–23 based on claims 12 and 14 alone.

Appellants argue that different epoxides can be used as the first and second epoxides in the process of claim 1 for preparing a bio-organic composition, and contend that the particular epoxides utilized in the process affect the viscosity and pour point of the composition produced. (App. Br. 8–9.)

However, claim 1 is directed to using either the same epoxides or different epoxides to produce bio-diesel fuel having the broadly recited viscosity and pour point characteristics, inclusive of those recited in claims 12 and 14. Moreover, as discussed above, one of ordinary skill in the art reasonably would have been led to use a combination of different epoxides, such as ethylene oxide and propylene oxide, in Erner's epoxide addition reaction to produce a bio-diesel fuel comprising hydroxylalkyl esters. In other words, we agree with the Examiner that the process of Erner alone, or as modified by Maurer, is identical or substantially identical to the method of claim 1 and produces the same or substantially the same bio-diesel fuel recited in claims 1, 12, and 14. (*See also* Erner col. 1, ll. 62–69.) Accordingly, we concur with the Examiner that the collective teachings of

Erner and Maurer would have suggested the process as recited in claim 1 to produce a bio-diesel fuel, inclusive of those bio-diesel fuels having particular viscosities and pour points recited in claims 1, 12, and 14. *See also Ex parte Obiaya*, 227 USPQ 58, 60 (BPAI 1985) ("The fact that appellant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious."); *In re Kubin*, 561 F.3d 1351, 1357 (Fed. Cir. 2009) ("Even if no prior art of record explicitly discusses the [limitation], [applicants'] application itself instructs that [the limitation] is not an additional requirement imposed by the claims on the [claimed invention], but rather a property necessarily present in [the claimed invention]"). On this record, Appellants do not show that such broadly recited viscosities and pour points of such bio-diesel fuel would further require unobvious steps or conditions in the process of claim 1 or would not be present in the bio-diesel fuel produced in the process suggested by Erner alone or Erner, as modified by Maurer. Accordingly, we sustain the rejection of claims 12–14 and 20–22 under 35 U.S.C. § 103(a).

CONCLUSION

In view of the reasons set forth above, we affirm the Examiner's rejection of claims 1 through 28 under § 103(a).

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

IV. CLAIMS APPENDIX

1. A method of forming a bio-organic composition, the method comprising:

a) mixing a fatty acid glyceride-containing composition and a first reaction promoter at a first predetermined temperature to form a first intermediate reaction mixture;

b) adding a first epoxide or glycol to the first reaction mixture to form a second intermediate reaction mixture;

c) combining at least a portion of the second intermediate reaction mixture with a solvent and additional reaction promoter to form a third intermediate reaction mixture;

d) adding a second epoxide to the third intermediate reaction mixture to form a fourth intermediate reaction mixture; and

e) removing the solvent such that the bio-organic composition is recovered.

2. The method of claim 1 wherein the fatty acid glyceride-containing composition comprises vegetable oil.

3. The method of claim 2 wherein the vegetable oil is selected from the group consisting of canola oil, coconut oil, corn oil, cotton seed oil, olive oil, grape seed oil, sunflower oil, palm oil, peanut oil, alfalfa oil, safflower oil, soybean oil, and combinations thereof.

4. The method of claim 1 wherein the fatty acid glyceride-containing composition comprises animal fat.

5. The method of claim 1 wherein the solvent added in step c) is water or an alcohol.

6. The method of claim 1 wherein the bio-organic composition includes water in an amount less than about 0.5 weight percent.

7. The method of claim 1 further comprising forming a fifth composition by adding one or more additional components to the fourth intermediate composition, the one or more addition components selected from the group consisting of additional epoxide, an alcohol, a reaction promoter and an ester.

8. The method of claim 7 wherein the ester is methyl soyate.

9. The method of claim 1 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 10 carbon atoms and combinations thereof.

10. The method of claim 1 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 8 carbon atoms.

11. The method of claim 1 wherein the first epoxide is ethylene oxide and the second epoxide propylene oxide.

12. The method of claim 1 wherein the bio-organic composition has a viscosity less than or equal to about 30 centipoise at 25^{o} C.

13. The method of claim 1 wherein the bio-organic composition has a viscosity less than or equal to about 20 centipoise at 25^{o} C.

14. (Original) The method of claim 1 wherein the bio-organic composition has a pour point less than or equal to about 0^{o} F.

15. The method of claim 1 wherein the bio-organic composition has a pour point less than or equal to about -20^{o} F..

16. A bio-organic composition comprising:

residues of a fatty acid glyceride-containing composition, the fatty acid glyceride-containing composition having a first viscosity and a first pour point;

residues of a first epoxide present in a first epoxide concentration or residues of a first glycol present in a first glycol concentration; and

residues of a second epoxide present in a second epoxide concentration, wherein the first epoxide is the same or different than the second epoxide and wherein the first and second concentrations are such that the bio-organic composition has a viscosity lower that the first viscosity and/or a pour point lower than the first pour point.

17. The bio-organic composition of claim 16 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 10 carbon atoms and combinations thereof.

18. The bio-organic composition of claim 16 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 8 carbon atoms.

19. The bio-organic composition of claim 16 wherein the first epoxide is ethylene oxide and the second epoxide is propylene oxide.

20. The bio-organic composition of claim 16 wherein the bio-organic composition has a viscosity less than or equal to about 30 centipoise at 25^{o} C.

21. The bio-organic composition of claim 16 wherein the bio-organic composition has a viscosity less than or equal to about 20 centipoise at 25^{o} C.

22. The bio-organic composition of claim 16 wherein the bio-organic composition has a pour point less than or equal to about 0^{o} F.

23. The bio-organic composition of claim 16 wherein the bio-organic composition has a pour point less than or equal to about -20^{o} F.

24. The bio-organic composition of claim 16 further comprising the residue of a reaction promoter.

25. A bio-diesel fuel comprising the bio-organic composition of claim 14.

26. A motor oil equivalent comprising the bio-organic composition of claim 14.

27. A fuel additive comprising the bio-organic composition of claim 14.

28. An internal combustion engine system comprising:

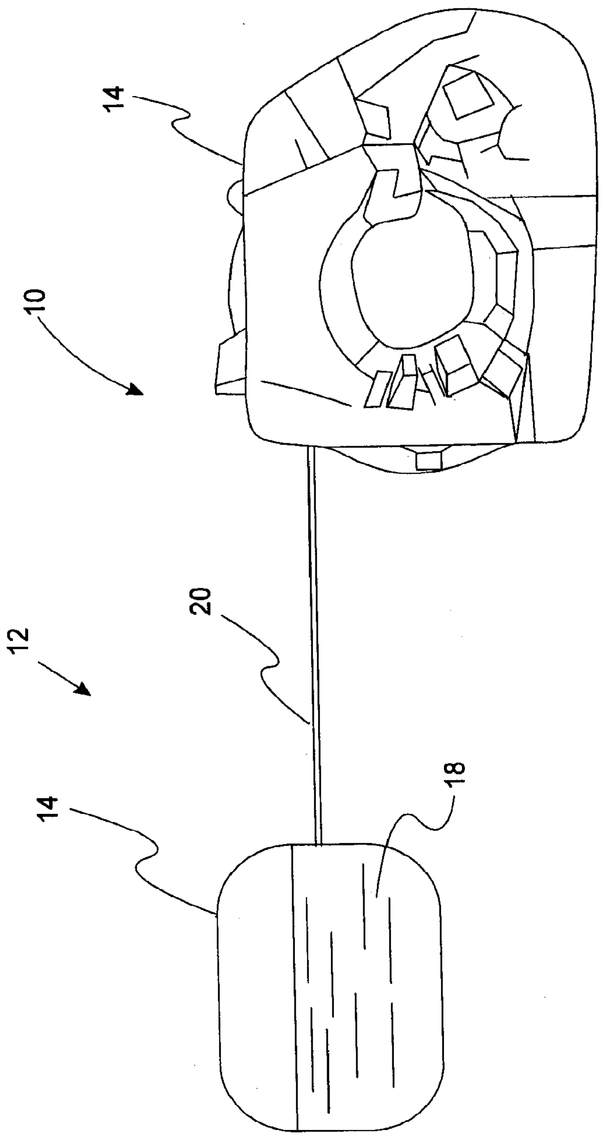
fuel supply system for providing a bio-diesel fuel composition, the bio-diesel fuel composition comprising:

residues of a fatty acid glyceride-containing composition, the fatty acid glyceride-containing composition having a first viscosity and a first pour point;

residues of a first epoxide present in a first epoxide concentration or the residues of a first glycol present in a first glycol concentration; and

residues of a second epoxide present in a second epoxide concentration, wherein the first epoxide when utilized is the same or different than the second epoxide and wherein the first and second concentrations are such that the bio-organic composition has a viscosity lower than the first viscosity and/or a pour point lower than the first pour point; and

an internal combustion engine in fluid communication with the fuel supply system, the internal combustion engine adapted to combust bio-diesel fuel received from the fuel supply system.


14
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12
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18

Figure 1

MODIFICATION OF FATS AND OILS FOR FUEL AND LUBRICATING APPLICATIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

In at least one aspect, the present invention is related to bio-diesel fuels derived from a fatty acid glyceride-containing composition and to systems utilizing such bio-diesel fuels.

2. Background Art

Although industrial advancement has been based on fossil fuel use, political and environmental concerns provide an impetus for the development of renewable energy sources. Fossil fuel use causes significant environmental concerns due to the release of such byproducts as carbon dioxide, nitrogen oxides, sulfur dioxide, organic compounds, and the like. Carbon dioxde is a greenhouse gas and is implicated as a causative agent in global warming. Notwithstanding the environmental issues, it is inevitable that the supply of fossil fuels will eventually be depleted because of the finite nature of these fuels. For example, by some estimates the supply of oil will last only about another 50 years.

Renewable energy sources hold the promises of supplying energy for an unlimited time period. Solar energy is one source of renewable energy that will undoubtedly last for the lifetime of the Earth. Biodiesel fuels are a type of diesel fuel derived from biological sources that may be used in various combustion devices. Typically, biodiesel fuels are derived from vegetable oils. Some types of biodiesel fuels are formulated to be used in diesel engines without engine modification. This is in contrast to straight vegetable oils ("SVO") and waste vegetable oils ("WVO") which typically require modification of such engines. In an early biodiesel application, vegetable oil is transesterified with an alcohol such as ethanol or methanol. Biodiesel fuel provide a number of additional advantages over fossil fuels. Biodiesel fuels are usually biodegradable while producing significantly less carbon dioxide than fossil fuels. Blends of biodiesel fuels with other diesel fuels are sometimes utilized. For example, "B20" is 20% biodiesel and 80% petroleum diesel.

Accordingly, for at least these reasons, there is a need for new methods for forming renewable energy sources and for systems utilizing such energy sources.

SUMMARY OF THE INVENTION

The present invention solves one or more problems of the prior art by providing in at least one aspect a method of forming bio-organic compositions that are useful for bio-diesel fuel, fuel blend, and motor oil applications. The method of the present embodiment includes a step in which a fatty acid glyceride-containing composition, a first epoxide or glycol, and a reaction promoter are reacted in a first step. In a subsequent step, the reaction mixture is further reacted with a second epoxide.

In another embodiment, the bio-organic composition formed by the methods of the invention is provided. The bio-organic composition of this embodiment includes residues of a fatty acid glyceride-containing composition. The fatty acid glyceride-containing composition is characterized by the viscosity at room temperature and a pour point. The bio-organic composition further includes residues of a first epoxide and/or a glycol and residues of a second epoxide. The first epoxide is the same or different than the second epoxide. The first epoxide and/or glycol and second epoxide are present in a sufficient amount that the room temperature viscosity of the bio-organic composition is lower than the room temperature viscosity of the pre-formulated fatty acid glyceride-containing composition and/or the pour point of the bio-organic composition is lower than the pre-formulated fatty acid glyceride-containing composition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic illustration of an internal combustion engine system using an embodiment of the present invention as a fuel.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Reference will now be made in detail to presently preferred compositions, embodiments and methods of the present invention, which constitute the best modes of practicing the invention presently known to the inventors. The Figures are not necessarily to scale. However, it is to be understood that the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for any aspect of the invention and/or as a representative basis for teaching one skilled in the art to variously employ the present invention.

Except in the examples, or where otherwise expressly indicated, all numerical quantities in this description indicating amounts of material or conditions of reaction and/or use are to be understood as modified by the word "about" in describing the broadest scope of the invention. Practice within the numerical limits stated is generally preferred. The description of a group or class of materials as suitable or preferred for a given purpose in connection with the invention implies that mixtures of any two or more of the members of the group or class are equally suitable or preferred; description of constituents in chemical terms refers to the constituents at the time of addition to any combination specified in the description, and does not necessarily preclude chemical interactions among the constituents of a mixture once mixed; the first definition of an acronym or other abbreviation applies to all subsequent uses herein of the same abbreviation and applies mutatis mutandis to normal grammatical variations of the initially defined abbreviation; and, unless expressly stated to the contrary, measurement of a property is determined by the same technique as previously or later referenced for the same property.

It is also to be understood that this invention is not limited to the specific embodiments and methods described below, as specific components and/or conditions may, of course, vary. Furthermore, the terminology used herein is used only for the purpose of describing particular embodiments of the present invention and is not intended to be limiting in any way.

It must also be noted that, as used in the specification and the appended claims, the singular form "a", "an", and "the" comprise plural referents unless the context clearly indicates otherwise. For example, reference to a component in the singular is intended to comprise a plurality of components.

Throughout this application, where publications are referenced, the disclosures of these publications in their entireties are hereby incorporated by reference into this application in their entirety to more fully describe the state of the art to which this invention pertains.

The term "fatty acid glyceride-containing composition" as used herein means a composition that includes a component selected from the group consisting of naturally occurring vegetable and animal fats and oils, partly or fully synthetic fatty acid glycerides, used fatty acid glycerides, and combinations thereof. In general, a fatty acid glyceride-containing composition includes fats and/or oils derived from living matter.

The term "vegetable oil" as used herein means the substances derived from plants consisting of triglycerides that are normally liquid at room temperature (i.e. 25° C).

The term "glyceride" or "fatty acid glyceride" as used herein is a compound in which glycerol is esterified with at least one fatty acid.

The term "triglyceride" or "fatty acid triglyceride" as used herein is a compound in which glycerol is esterified with three fatty acids.

The term "diesel fuel" as used herein means a fuel that is usable in a diesel engine. Diesel fuels usually include saturated hydrocarbons and aromatic hydrocarbons. A typical diesel fuel usually includes components having a chemical formula from about $C_{10}H_{22}$ to $C_{15}H_{32}$.

The term "gasoline" as used herein means a petroleum-derived mixture that includes hydrocarbons and is used to fuel an internal combustion vehicle.

A "residue of a fatty acid glyceride-containing composition" as used herein means a chemical moiety integrated in a product compound that is derived from a fatty acid glyceride-containing composition. In one refinement, the residue of a fatty acid glyceride-containing composition is a residue of a vegetable oil. In another refinement, the residue of a fatty acid glyceride-containing composition is a residue of an animal fat.

A "residue of a epoxide" as used herein means a chemical moiety integrated in a product compound that is derived from an epoxide.

The term "pour point" as used herein means the lowest temperature at which a liquid specimen can be poured. In a variation, the pour point is the lowest temperature at which movement of a test specimen is observed under prescribed conditions as described by D97- 06. Pour point is usually specified for petroleum products. The entire disclosure of D97-06 is hereby incorporated by reference.

The term "reaction promoter" as used herein means any chemical species that facilitates a chemical reaction. Such promoter may initiate a reaction and accelerate a reaction. Reaction promoters include, but are not limited to, catalysts. In a variation of the present invention, reaction promoters are bases.

In an embodiment of the present invention, a method for forming a bio-organic composition is provided. The bio-organic composition made by the method of the invention includes residues of a fatty acid glyceride-containing composition. In one refinement, the fatty acid glyceride-containing composition includes animal fat or oil. In another refinement, the fatty acid glyceride-containing composition includes vegetable fat or oil. In a further refinement, the vegetable oil is characterized by a viscosity at room temperature and a pour point prior to formulation in the present embodiment. The bio-organic composition further include residues of a first epoxide or a glycol and residues of a second epoxide. The first epoxide when present is the same or different than the second epoxide. In a variation, the first epoxide or glycol and the second epoxides are present in a sufficient amount that the room temperature viscosity of the bio-organic composition is lower than the room temperature viscosity of the pre-formulated fatty acid glyceride-containing composition. In another variation, the first epoxide or glycol and the second epoxides are present in a sufficient amount that the pour point of the bio-organic composition is lower than the pour point of the pre-formulated fatty acid glyceride-containing composition. In a refinement of the present invention, the pour point of the bio-organic compositions is less than or equal to, in increasing order of preference, 0° F, -10° F, -20° F, -30° F, -40° F, and -50° F. In another refinement, the pour point of the bio-organic compositions is greater than or equal to, in increasing order of preference, -30° F, -40° F, -50° F, -60° F, and -65° F. Generally, the pour point of the bio-organic compositions is from -50° F to 0° F. Some compositions of the present invention are characterized by having an ignition temperature from about 180° F to about 260° F. Other compositions of the present invention are characterized by having an ignition temperature from about 200° F to about 250° F.

In a variation of the present embodiment, the bio-organic compositions have a free glycerol concentration less than about 5 wt %. In a further refinement, the bio-organic compositions have a free glycerol concentration less than about 2 wt %. In another refinement, the bio-organic compositions have a free glycerol concentration less than about 1 wt %. In still another refinement, the bio-organic compositions have a free glycerol concentration less than about 0.5 wt %. In yet another refinement, the bio-organic compositions have a free glycerol concentration less than about 0.1 wt %. In a particularly useful refinement of the invention, the free glycerol concentration is substantially zero. It should be readily apparent that the bio-organic compositions posses such low free glycerol concentrations because of partial reactions (e.g., hydrolysis) of the fatty acid glyceride-containing composition. Such partially reaction results in glycerol remaining esterified with one or two acid groups from the initial fatty acid glyceride-containing composition.

The method of the present invention includes a step in which fatty acid glyceride-containing composition and a reaction promoter (e.g., potassium hydroxide, sodium hydroxide, etc.) are mixed together and then reacted at a first predefined temperature and pressure to form a first intermediate composition. In one refinement, the fatty acid glyceride-containing composition includes animal fat or oil. In another refinement, the fatty acid glyceride-containing composition includes vegetable fat or oil. This reaction temperature is typically greater than room temperature and the pressure is elevated (greater than about 1.1 atm). Typically, the pressure is initially elevated (several PSI over atmospheric pressure) do to the addition of inert gas (e.g., nitrogen). The pressure will rise during reaction and then decrease towards the initial pressure as the reaction completes. The pressure rise may be from about 5 to 50 PSI. This of course will be dependent on the particular reaction being run. In a refinement of the method, the reaction temperature is from 200° F to about 350° F. In another refinement of the invention, the reaction temperature is from about 250° F to about 300° F. In still another refinement of the invention, the reaction temperature is from about 270° F to about 280° F. Optionally, this reaction is performed in a pressure reactor operating at an elevated pressure (greater than about 1.1 atm). The first epoxide or glycol is then added while maintaining the temperature and pressure of the first intermediate composition to form the second intermediate composition. The amounts of fatty acid glyceride-containing composition, ethylene oxide or glycol and reaction promoter are chosen to suit a desired application. Typically, the amount of fatty acid glyceride-containing composition is from about 35 to about 85 parts by weight. All percentages and parts as used herein are weight percentages and parts by weight unless stated to the contrary. In a variation, the amount of fatty acid glyceride-containing composition is from about 45 to about 75 parts by weight. In another variation, the amount of fatty acid glyceride-containing composition is from about 50 to about 65 parts by weight. Typically, the first epoxide or glycol is present in an amount from about 2 parts by weight to about 15 parts by weight. In a variation, the amount of the first epoxide or glycol is from about 5 to about 10 parts by weight. In another variation, the amount of the first epoxide or glycol is from about 6 to about 8 parts by weight. Finally, the reaction promoter is typically present in an amount from about 0.5 parts by weight to about 10 parts by weight. In a variation, the amount of the reaction promoter is from about 5 to about 10 parts by weight. In another variation, the amount of the reaction promoter is from about 6 to about 8 parts by weight.

In a second step, the second intermediate composition is reacted with a solvent such as water or an alcohol (e.g., methanol, ethanol). An additional amount of reaction promoter is then added to form a third intermediate composition. The temperature and pressure is maintained in the ranges set forth above. A fourth intermediate composition is formed by adding the second epoxide while maintaining the temperature in the provided ranges. After the entire second epoxide is added, the fourth reaction mixture is maintained at an elevated temperature for a predetermined period of time. Typically, this predetermined period of time is about an hour. The method described thus far is useful for forming a composition utilized as a motor oil substitute.

In a variation of the method of the invention, a method for forming a composition for utilization as a bio-diesel fuel is provided. In this variation, additional epoxide, an alcohol (such as methanol) and a reaction promoter is reacted in a fifth step. Usually, these additional ingredients are added to the fourth intermediate composition to form a fifth composition. Methyl Soyate may also be added after the completion of this step. In a refinement of this variation, at least a portion of the additional epoxide, alcohol, and reaction promoter form a separate compound from the compounds formed thus far from the fatty acid glyceride-containing composition.

In a further variation of the method of the invention, a method for forming bio gasoline is provided. In this variation, the fourth intermediate composition described is blended with gasoline as set forth below. In a refinement, this blend comprises from about 10 to about 30 weight percent of the bio-organic composition and from about 70 to about 90 weight percent gasoline. In another refinement, this blend comprises about 20 weight percent of the bio-organic composition and about 80 weight percent gasoline.

In a variation of the invention, the bio-organic compositions of the present embodiment includes a vegetable oil. Examples of suitable vegetable oils include, but are not limited to, canola oil, coconut oil, corn oil, cotton seed oil, olive oil, grape seed oil, sunflower oil, palm oil, peanut oil, alfalfa oil, safflower oil, soybean oil, and combinations thereof. Soybean oil, alfalfa oil, palm oil, sunflower oil, and combinations thereof are particularly useful in the formulations of the present invention.

In a variation of the present embodiment, the first epoxide or glycol and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 10 carbon atoms and combinations thereof. In another variation of the present embodiment, the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 8 carbon atoms. When a glycol is used, the glycol has from 2 to 8 carbon atoms. In a particularly useful variation, the first epoxide or glycol and the second epoxide are different and selected from ethylene oxide and propylene oxide. Typically, the first epoxide is ethylene oxide and the second epoxide is propylene oxide. When utilized, the glycol is typically ethylene glycol.

Advantageously, the bio-organic formulation is formulated to have a viscosity suitable for bio-diesel applications or motor oil applications. To this end, the bio-organic formulation has a viscosity at 25° C, in order of preference, less than or equal to 90 centipoise, 50 centipoise, 40 centipoise, 30 centipoise, 20 centipoise, 19 centipoise, 18 centipoise, 17 centipoise, and 16 centipoise. The bio-organic compositions are also characterized by having a viscosity at 25° C, in order of preference, greater than or equal to 5 centipoise, 7 centipoise, 10 centipoise, 11 centipoise, 12 centipoise, 13 centipoise, 14 centipoise, 15 centipoise, and 16 centipoise. Bio-organic compositions having a viscosity at 25° C from about 15 to 20 centipoise are particularly useful for bio-diesel applications.

In a variation of the present embodiment, the bio-organic composition further includes a diesel fuel composition that is different than the bio-organic composition without this added diesel fuel composition. In a refinement, the added diesel fuel is present in an amount from about 1 weight % to about 99 weight %. In a further refinement, the added diesel fuel is present in an amount from about 5 weight % to about 50 weight %. In still another refinement, the added diesel fuel composition is present in an amount that is greater than or equal to, in increasing order of preference, 1 weight %, 5 weight %, 10 weight %, 15 weight %, 20 weight %, 90 weight %, 80 weight %, 70 weight %, 60 weight %, 50 weight %, 40 weight %, 30 weight %, and 25 weight %. In still another refinement, the added diesel fuel composition is present in an amount that is less than or equal to, in increasing order of preference, 5 weight %, 10 weight %, 15 weight %, 20 weight %, 25 weight %, 99 weight %, 90 weight %, 80 weight %, 70 weight %, 60 weight %, 50 weight %, 40 weight %, and 30 weight %. In a particularly useful variation, the added diesel fuel is present in an amount from about 10 weight percent to about 30 weight percent. Suitable examples of the additional diesel fuel include a diesel fuel set forth in ASTM D975-07a, the entire disclosure of which is hereby incorporated by reference. Such fuels include Grade No. 1-D S15 which is a light middle distillate fuel for use in diesel engine applications requiring a fuel with a maximum 15 ppm sulfur, Grade No. 1-D S500 which is a light middle distillate fuel for use in diesel engine applications requiring a fuel with a maximum of 500 ppm sulfur; Grade No. 1-D S5000 which is a light middle distillate fuel for use in diesel engine applications requiring a fuel with a maximum of 5000 ppm sulfur; Grade No. 2-D S15 which is a middle distillate fuel for use in diesel engine applications requiring a fuel with maximum of 15 ppm sulfur; Grade No. 2-D S500 which is a middle distillate fuel for use in diesel engine applications requiring a fuel with maximum 500 ppm sulfur; Grade No. 2-D S5000 which is middle distillate fuel for use in diesel engine applications requiring a fuel with maximum 5000 ppm sulfur; and a combination thereof.

In another variation of the present embodiment, the bio-organic composition further includes a gasoline composition (e.g., gasoline). In a refinement, the added gasoline is present in an amount from about 1 weight % to about 99 weight %. In a further refinement, the added gasoline is present in an amount from about 5 weight % to about 50 weight %. In still another refinement, the added gasoline composition is present in an amount that is greater than or equal to, in increasing order of preference, 1 weight %, 5 weight %, 10 weight %, 15 weight %, 20 weight %, 90 weight %, 80 weight %, 70 weight %, 60 weight %, 50 weight %, 40 weight %, 30 weight %, and 25 weight %. In still another refinement, the added gasoline composition is present in an amount that is less than or equal to, in increasing order of preference, 5 weight %, 10 weight %, 15 weight %, 20 weight %, 25 weight %, 99 weight %, 90 weight %, 80 weight %, 70 weight %, 60 weight %, 50 weight %, 40 weight %, and 30 weight %.

In still another variation of the present invention, the variations and refinements set forth above further include a fuel additive. Examples of useful fuel additives include alcohols (e.g., ethanol, methanol), benzene, iso-octane and the like. In one refinement, the fuel additive is an alcohol, such as ethanol and methanol, present in an amount less than or equal to about 30 weight percent. In another refinement, the fuel additive is an alcohol, such as ethanol or methanol, present in an amount less than or equal to about 25 weight percent. In another refinement, the fuel additive is an alcohol, such as ethanol or methanol, present in an amount greater than or equal to about 1 weight percent. In still another refinement, the fuel additive is an alcohol, such as ethanol or methanol, present in an amount greater than or equal to about 5 weight percent. In still another refinement, the fuel additive is an alcohol such as ethanol or methanol, present in an amount greater than or equal to about 10 weight percent. In yet another refinement, the fuel additive is an alcohol, such as ethanol or methanol, present in an amount less than or equal to about 15 weight percent.

In another embodiment of the present invention, an internal combustion engine system utilizing the bio-diesel fuel compositions, bio-organic compositions, and blends set forth above is provided. With reference to Figure 1, a schematic illustration of the internal combustion engine system is provided. Internal combustion engine system 10 includes fuel supply system 12 and internal combustion engine 14. Fuel supply system 12 includes fuel tank 16 which holds bio-diesel fuel 18 and fuel line 20. Bio-diesel fuel 18 is supplied to engine 14 via fuel line 20. Bio-diesel fuel 18 is combusted in engine 14 providing useful work as known to those skilled in the art of automotive engine design.

The following examples illustrate the various embodiments of the present invention. Those skilled in the art will recognize many variations that are within the spirit of the present invention and scope of the claims.

Example 1

A bio-organic composition is formed by mixing about 59 parts soybean oil with about 3 parts potassium hydroxide in a closed/pressured mixing vessel to form a first intermediate composition. The first intermediate composition is heated to a temperature from 270° F to 280° F at a pressure greater than 1.1 atm. While the temperature is maintained within this range, about 7 parts by weight ethylene oxide is added to form a second intermediate reaction mixture. A third intermediate mixture is formed from about 56 parts of the second intermediate reaction mixture, 13 parts water, and 3 parts potassium hydroxide. The temperature of the third reaction mixture is maintained at a temperature of about 270° F to 280° F for an additional hour. While maintaining the temperature, about 21 parts propylene oxide are added. The water is then removed under a vacuum of about 26 inches of mercury to a final product having a water content less than about 0.5 weight percent water. This composition is useful as a motor oil substitute.

Example 2

A bio-organic composition is formed by mixing about 59 parts soybean oil with about 3 parts potassium hydroxide in a closed/pressure blending vessel (at a pressure greater than 1.1 atm) to form a first intermediate composition. The first intermediate composition is heated to a temperature from 270° F to 280° F. While maintaining the temperature within this range, about 7 parts by weight ethylene oxide is added to form a second intermediate reaction mixture. A third intermediate mixture is formed from about 56 parts of the second intermediate reaction mixture, 13 parts water, and 3 parts potassium hydroxide. The third reaction mixture is maintained at a temperature from about 270° F to 280° F for an additional hour. About 15 parts propylene oxide are added while maintaining the temperature and pressure to form a fourth intermediate mixture. Additional epoxides (4 to 10 parts by weight) and about 8 parts methanol in the presence of a reaction promoter are reacted to form a fifth intermediate mixture. The water is then removed under a vacuum of about 26 inches of mercury to a final product having a water content less than about 0.5 weight percent water. This composition is useful with modifications (including the optional addition of methyl soyate) as a bio-diesel fuel.

Example 3

A bio-organic composition is formed by mixing about 59 parts soybean oil with about 3 parts potassium hydroxide in a closed/pressured blending vessel (at a pressure greater than 1.1 atm) to form a first intermediate composition. The first intermediate composition is heated to a temperature from about 270° F to about 280° F. While maintaining the temperature within this range, about 7 parts by weight ethylene oxide is added to form a second intermediate reaction mixture. A third intermediate mixture is formed from about 56 parts of the second intermediate reaction mixture, 13 parts water and about 3 parts potassium hydroxide. The third reaction mixture is maintained at a temperature from about 270° F to about 280° for an additional hour. About 15 parts propylene oxide are added while maintaining the temperature and pressure. The water is then removed under a vacuum of about 26 inches of mercury to a final product having a water content less than about 0.5 weight percent water. This composition may be blended with gasoline as set forth below. In one instance, the blend includes from about 10 to about 30 weight percent of the bio-organic composition and from about 70 to 90 weight percent gasoline. In another instance, the blend includes about 20 weight percent of the bio-organic composition and about 80 weight percent gasoline. This composition is useful as a bio-gasoline.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A method of forming a bio-organic composition, the method comprising:

a) mixing a fatty acid glyceride-containing composition and a first reaction promoter at a first predetermined temperature to form a first intermediate reaction mixture;

b) adding a first epoxide or glycol to the first reaction mixture to form a second intermediate reaction mixture;

c) combining at least a portion of the second intermediate reaction mixture with a solvent and additional reaction promoter to form a third intermediate reaction mixture;

d) adding a second epoxide to the third intermediate reaction mixture to form a fourth intermediate reaction mixture; and

e) removing the solvent such that the bio-organic composition is recovered.

2. The method of claim 1 wherein the fatty acid glyceride-containing composition comprises vegetable oil.

3. The method of claim 2 wherein the vegetable oil is selected from the group consisting of canola oil, coconut oil, corn oil, cotton seed oil, olive oil, grape seed oil, sunflower oil, palm oil, peanut oil, alfalfa oil, safflower oil, soybean oil, and combinations thereof.

4. The method of claim 1 wherein the fatty acid glyceride-containing composition comprises animal fat.

5. The method of claim 1 wherein the solvent added in step c) is water or an alcohol.

6. The method of claim 1 wherein the bio-organic composition includes water in an amount less than about 0.5 weight percent.

7. The method of claim 1 further comprising forming a fifth composition by adding one or more additional components to the fourth intermediate composition, the one or more addition components selected from the group consisting of additional epoxide, an alcohol, a reaction promoter and an ester.

8. The method of claim 7 wherein the ester is methyl soyate.

9. The method of claim 1 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 10 carbon atoms and combinations thereof.

10. The method of claim 1 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 8 carbon atoms.

11. The method of claim 1 wherein the first epoxide is ethylene oxide and the second epoxide propylene oxide.

12. The method of claim 1 wherein the bio-organic composition has a viscosity less than or equal to about 30 centipoise at 25° C.

13. The method of claim 1 wherein the bio-organic composition has a viscosity less than or equal to about 20 centipoise at 25° C.

14. The method of claim 1 wherein the bio-organic composition has a pour point less than or equal to about 0° F.

15. The method of claim 1 wherein the bio-organic composition has a pour point less than or equal to about -20° F..

16. A bio-organic composition comprising:

residues of a fatty acid glyceride-containing composition, the fatty acid glyceride-containing composition having a first viscosity and a first pour point;

residues of a first epoxide present in a first epoxide concentration or residues of a first glycol present in a first glycol concentration; and

residues of a second epoxide present in a second epoxide concentration, wherein the first epoxide is the same or different than the second epoxide and wherein the first and second concentrations are such that the bio-organic composition has a viscosity lower that the first viscosity and/or a pour point lower than the first pour point.

17. The bio-organic composition of claim 16 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 10 carbon atoms and combinations thereof.

18. The bio-organic composition of claim 16 wherein the first epoxide and the second epoxide are each individually selected from the group consisting of epoxides having from 2 to 8 carbon atoms.

19. The bio-organic composition of claim 16 wherein the first epoxide is ethylene oxide and the second epoxide is propylene oxide.

20. The bio-organic composition of claim 16 wherein the bio-organic composition has a viscosity less than or equal to about 30 centipoise at 25° C.

21. The bio-organic composition of claim 16 wherein the bio-organic composition has a viscosity less than or equal to about 20 centipoise at 25° C.

22. The bio-organic composition of claim 16 wherein the bio-organic composition has a pour point less than or equal to about 0° F.

23. The bio-organic composition of claim 16 wherein the bio-organic composition has a pour point less than or equal to about -20° F.

24. The bio-organic composition of claim 16 further comprising the residue of a reaction promoter.

25. A bio-diesel fuel comprising the bio-organic composition of claim 14.

26. A motor oil equivalent comprising the bio-organic composition of claim 14.

27. A fuel additive comprising the bio-organic composition of claim 14.

28. An internal combustion engine system comprising:

a fuel supply system for providing a bio-diesel fuel composition, the bio-diesel fuel composition comprising:

residues of a fatty acid glyceride-containing composition, the fatty acid glyceride-containing composition having a first viscosity and a first pour point;

residues of a first epoxide present in a first epoxide concentration or the residues of a first glycol present in a first glycol concentration; and

residues of a second epoxide present in a second epoxide concentration, wherein the first epoxide when utilized is the same or different than the second epoxide and wherein the first and second concentrations are such that the bio-organic composition has a viscosity lower than the first viscosity and/or a pour point lower than the first pour point; and

an internal combustion engine in fluid communication with the fuel supply system, the internal combustion engine adapted to combust bio-diesel fuel received from the fuel supply system.

ABSTRACT OF THE DISCLOSURE

A bio-organic composition includes residues of a fatty acid glyceride-containing composition, residues of a first epoxide or glycol, and the residues of a second epoxide. The fatty acid glyceride-containing composition is characterized by the viscosity at room temperature. The first epoxide or glycol and second epoxides are present in a sufficient amount that the room temperature viscosity of the bio-organic composition is lower than the room temperature viscosity of the vegetable oil prior to formulation and/or the first epoxide or glycol and second epoxides are present in a sufficient amount that the pour point of the bio-organic composition is lower than the pour point of the fatty acid glyceride-containing composition prior to formulation.

CERTIFICATE OF ELECTRONIC SERVICE

I certify that I served a copy of **BRIEF OF APPELLANTS JOHN RISSIO AND JOHN CAMERON** on counsel of record on February 3, 2017 by:

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CERTIFICATE OF COMPLIANCE

This brief complies with the type-volume limitation of Federal Rule of Appellate Procedure 32(a)(7)(B). The brief contains 4386 words, excluding the parts of the brief exempted by Federal Rule of Appellate Procedure 32(a)(7)(B)(iii).

This brief complies with the typeface requirements of Federal Rule of Appellate Procedure 32(a)(5) and the type style requirements of Federal Rule of Appellate Procedure 32(a)(6). The brief has been prepared in a proportionally spaced typeface using Microsoft® Word 2010 and Times New Roman typeface, 14-point.

Respectfully submitted,

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